**University of Maryland Robotics Facilities**

**University of Maryland Unmanned Aircraft Systems Test Site:** The University of Maryland Unmanned Aircraft Systems (UAS) Test Site is a research and operations facility based in California, Maryland that works with university, government, and private partners to advance UAS research and demonstrate operational capabilities. The test site boasts more than 50 vehicles ranging from 2 to 500 lbs and access to restricted airspace where they can operate up to 10,000 feet. The site also has authorizations to fly beyond line of sight, at night, and in operations involving multiple aircraft. Formed in 2014, the UAS Test Site is one of only a handful of institutions across the country that work directly with the Federal Aviation Administration, with the ultimate objective of seamlessly integrating UAS into national airspace.

**Fearless Flight Facility:** The Fearless Flight Facility (F3) is the only university outdoor flight laboratory for testing unmanned aircraft systems (UAS) in the D.C.-Maryland-Virginia region. The 100-foot wide, 300-foot long, and 50-foot high facility serves as a critical nexus between the Clark School of Engineering’s College Park labs and UMD’s UAS Test Site in Maryland’s St. Mary’s County.

**Brin Family Aerial Robotics Lab:** The University of Maryland (UMD) received a generous gift from the Brin Family to support excellence in drone-related activity and inspire UMD students, faculty and staff engaged in research, competitions and activities involving unmanned aerial vehicles. As part of this gift, Paley oversees the Brin Family Drone Lab on the first floor of the Brendan Iribe Center for Computer Science and Engineering. This lab is a large shared space for indoor drone testing, including high-precision motion capture cameras, numerous workbenches and storage space.

**Alfred Gessow Rotorcraft Center:** Since 1982, the Alfred Gessow Rotorcraft Center at the University of Maryland has been one of the three Rotorcraft Centers of Excellence, supported for most of the years by the Army Research Office (1982–95) and later on by the Army/NASA National Rotorcraft Technology Center (1996–2006, 2011–present). The Center carries out multi- disciplinary/ interdisciplinary research on various aeromechanics disciplines of rotorcraft systems including eVTOL manned and unmanned platforms.

**Neutral Buoyancy Research Facility:** NBRF is one of two currently operating neutral buoyancy tanks in the US. It is the only one located on a college campus and the only one dedicated to basic research. The tank is 50 feet across, 25 feet deep, and holds 367,000 gallons of water (about the same as three municipal swimming pools). The NBRF also has complete SCUBA diver support facilities, including two locker rooms, air compressors for filling SCUBA bottles, and an underwater communications system. The NBRF is equipped with sixteen Qualisys underwater motion-capture cameras and supporting digital-image capturing equipment.

**Robotics Realization Lab:** RRL supports faculty and students in the Maryland Robotics Center by providing the most advanced human-safe robots for manufacturing and medical applications as well as mechanical and electrical rapid prototyping equipment to support the development of robot hardware that is not commercially available. Robots include 2 Kuka iiwa 7-axis arms, a Rethink Robotics Baxter, a Rethink Robotics Sawyer, Robotiq and RightHand ReFlex grippers, a Segway RMP-440LE, multiple Crazyflie quadrotors, and multiple TurtleBots. Sensors in the lab include an 8-camera Optitrack Prime 17w motion capture system, a Velodyne Puck LIDAR system, and various cameras and image sensors. Fabrication equipment includes an Objet30 Pro, uPrint SE Plus, Roland MDX-540SA 4-axis mill, Universal VLS3.50 Laser Cutter, Westbond 7476E wirebonder, Zephyrtronics solder station, erlab Green filtered fume hood, MDO4054 mixed domain scope and various electronics prototyping equipment. This lab is staffed full time by a lab manager that can also help with hardware integration.

**Research Prototyping Lab and MakerBot Innovation Center (Terrapin Works):** The UMD Clark School of Engineering provides the following shared equipment/resources: 3D Systems ProX 200, Stratasys Object500 Connex, Nanoscribe Photonic Professional GT, 33 Replicator 5th Generation Desktop 3D Printers, 13 MakerBot Replicator 2X Experimental 3D Printers, 2 Maker- Bot Replicator Z18 Desktop 3D Printers, 2 MakerBot Replicator Mini 3D Printers, 2 MakerBot Digitizer Desktop 3D Scanners.

**Robotics Manipulator Lab:** Features several state-of-the-art manipulators (2 x KUKA LBR iiwa 7, Sawyer, Baxter, UR3e, UR5e) as well as various interchangeable robotic grippers. Manipulators can be easily repositioned into different configurations to allow for collaborative projects with multiple manipulators. The lab works as a shared facility and provides access to all MRC faculty and affiliated students.

**List of equipment in MRC labs**

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| **MRC Lab** | **Equipment** |
| Robotics Realization Lab | **Robotic equipment:**   * robotic mobile platforms (2 x TurtleBot2, 7 x TurtleBot3, 3 x Crazyflie2.0, Segway RMP-440LE, ) * Optitrack Prime 17w motion capture system with 8 cameras * optical sensors (VLP-16 Puck LiDAR, Hokuyo 10LX LiDAR, solid state LiDAR Leddar, ZED stereo camera, DVS128 dynamic vision camera, Microsoft Kinect, and other smaller sensors) * Oculus Rift with dedicated PC * Niveus 4904GT computing workstation * various components and accessories for building robots   **Manufacturing equipment:**   * 3d printers (uPrint SE Plus and PRUSA i3 MK3S FDM printers, Objet30 Pro SLA printer, ANYCUBIC Photon UV LCD 3D Printer) * Roland MDX-540SA 4-axis mill, WEN drill press * Universal VLS3.50 Laser Cutter * Westbond 7476E wirebonder * soldering equipment (Zephyrtronics solder/desolder station and Metcal soldering iron) * Erlab filtered fume hood * convection oven, Thinky mixer, small spin coater, Branson sonicator, hot plates, Sartorius analytical balance, California Air Tools compressors, Whynter freezer   **Equipment for conducting experiments:**   * various electronics prototyping equipment (MDO4054 mixed domain scope, function generator, Keithley and TTi power supplies, PC with GPIB interface, etc) * Thorlabs optical table * 3x Thorlabs motorized translation stage PT1-Z8 * ATI force sensor Nano17 * high speed camera UX100 * Signatone probe station |
| Brin Family Aerial Robotics Lab | * 15 ft high 430 sq.ft netted area * Vicon motion capture system with 12 Vantage V8 cameras * components for drones assembly including Nvidia Jetson TX2, Lumenier carbon fiber frames, Intel stereo cameras, KDE Direct motors and ESCs, FrSky radio transmitter, mRobotics GPS, other optical and range sensors. * prototyping bench * ceiling Panasonic projectors |
| Robotics Manipulator Lab | * robotic arms (2 of 7-axis Kuka LBR iiwa, Baxter and Sawyer from Rethink Robotics, 2 of UR3e and UR5e from Universal Robots) * robotic grippers (ReFlex TakkTile 1 and 2 from RightHand Robotics, 2 of Robotiq 2 finger adaptive gripper, gripper kit for Rethink Robotics arms, Robotiq 3-Finger Gripper) * Soft Robotics Development Kit – UR+ * Husky A200 unmanned ground vehicle * motorized haptic device Geomagic Touch * Axia80‐M8 RS485 F/T Sensor * Rotopod R2000 from Mikrolar |